F1-163

Effects of Chemical Stresses on Chinook Salmon Smolt Survival in the San Joaquin River.

Prepared for

CALFED BAY-DELTA PROGRAM
1416 Ninth Street, Suite 1155
Sacramento, California 95814

Prepared by

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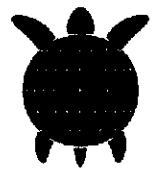
RFP Project Group 3, Other Services



GARCIA AND ASSOCIATES
NATURAL RESOURCES CONSULTANTS

GANDA

PHONE 415.789.9242
FAX 415.789.9245

July 28, 1997

Ms Kate Hansel
CALFED Bay-Delta Program
1416 Ninth Street
Suite 1155
Sacramento, CA 95814

RE: Proposal Submission for 1997 Category III funding

Dear Ms. Hansel:

Garcia and Associates and our subcontractor EA Engineering, Science and Technology are pleased to submit ten (10) copies of a proposal for the 1997 Category III Ecosystem Restoration Projects Programs. This proposal, entitled "Effects of Chemical Stresses on Chinook Salmon Smolt Survival in the San Joaquin River" is proposed for the Services Category of Programs.

If you have any questions, please call me at (415) 789-9242.

Sincerely,

John Garcia
Systems Ecologist/ Principal

GANDA

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I. EXECUTIVE SUMMARY

a. Project Title and Applicant Name

Title: Effects of Chemical Stresses on Chinook Salmon Smolt Survival in the San Joaquin River
Applicant Name: Garcia and Associates (GANDA)

b. Project Description and Primary Biological /Ecological Objectives

Populations of chinook salmon smolts and adults have experienced significant declines in the Sacramento/San Joaquin River Delta in the past several decades. The most commonly cited explanations for outmigration failure of chinook salmon smolts are San Joaquin River flows, elevated temperatures and entrainment losses. Flow, however, is a composite factor that encompasses many other variables, such as toxics loads, temperature variation, flow velocity, predator density, and food availability. Current models of smolt survival are unable to distinguish between the effects of these individual variables. An additional gap in knowledge relates to geographic information on smolt mortality. Current gross estimates of smolt survival depend on counts of coded wire-tagged fish made at the western edge of the Delta (near Chipps Island) which leaves stakeholders unable to identify or pinpoint the factors that may affect smolt survival as they pass through the lower San Joaquin and the main body of the Delta itself. Chemical water quality related variables are thought to negatively affect smolt survival and health but have not been evaluated in a quantifiable and predictable manner. Pesticides, metals and non-chloride ionic constituents are known to occur in large segments of the San Joaquin River system at concentrations that may cause severely adverse effects on smolts and other aquatic biota.

The goal of this proposal is to identify whether toxic chemicals play a role in smolt survival and to quantify such effects in a predictable manner. Specifically, this proposal will evaluate whether pesticides, metals and non-chloride ionic constituents in water (and in sediments that may release chemicals to the water column) affect smolt survival directly or indirectly during the period when they are traveling through the Delta.

The biological benefits of this project include real-time monitoring of the health of smolt migration populations and the specific conditions affecting them, and insights as to sources of agricultural drainage (e.g., pesticides, metals, nonchloride ions) and other activities that may be exercising toxic effects on smolts. This project is proposed as a 3-year effort; however, funding is requested only for the first year. The scope and funding for later years will depend on the findings of the first year's work.

c. Approach/Tasks/Schedule

Because the Lower San Joaquin River basin and the Delta form an extremely complex system of waterways, flows, water quality, and ecology, all of which may affect smolt survival, this study proposes a simplified approach that will focus first on understanding water quality in the mainstem of the lower San Joaquin River during the time of smolt outmigration in the first phase of the study. Succeeding phases of the project will focus on achieving better understanding of smolt condition, e.g., use of "live car" studies, bioassays, and/or additional sampling locations within the Delta. The toxics study will gather intensive, real-time data relating to water and sediment quality and smolt migration. The influence of pesticides, metals and ionic constituents will be assessed by linking water quality, sediment quality, and food availability with smolt condition. The sampling program will commence during the period of release of coded wire-tagged smolts (late April 1998) and will continue through the time of recapture at Chipps Island and/or Jersey Point (late May 1998). Smolts, as well as water, sediment, and zooplankton samples, will be collected at the Mossdale release point, at four intervening locations within the Delta and from the Jersey Point recapture location.

The data derived from this sampling effort will be used to determine whether quantifiable, predictable relationships exist between ambient chemical concentrations of metals, pesticides, non-chloride ions and nutrients (in water and sediment) and (1) smolt tissue concentrations, (2) availability of zooplanktonic food sources for smolts (3) ionic stress in smolt and (4) potential for adverse effects on smolt survival, growth or metabolism. A population model for smolt survival will be developed that will evaluate the contribution of the several other variables in conjunction with flow. In addition, an existing population model for adult chinook salmon (EACH) will be modified and refined using these data.

d. Justification for Project and Funding by CALFED

The San Joaquin River chinook salmon has been listed as a priority species by CALFED. The San Joaquin River as it affects the smolt has also been listed under CALFED's ecosystem restoration priorities. This project primarily addresses Item 4 (Water Quality) and secondarily addresses Item 5 (Temperature) both identified as stressors affecting priority species and habitats.

e. Budget Costs and Third Party Impacts

The cost for this project is estimated at 674,896.90 for the first year of 3 years. A cost-sharing commitment is provided by eliminating usage and rental charges by $65,380 by EA and reduction of fees by GANDA $12,855 resulting in a funding request to CALFED of **$596,662**. Budgets for succeeding years will be estimated based upon the results of the first year's study.

f. Applicant Qualifications

All members of the proposed team have relevant experience. Mr. Garcia of Garcia and Associates has extensive experience in assessing flow, temperature and fisheries issues in the Delta. The subcontractor team of EA Engineering, Science and Technology will be headed by Dr. Vedagiri, an aquatic toxicologist with research and project experience on the distribution and effects of toxicants on zooplankton and fish and in ecological risk assessments. David Hanson and Dr. Ed Cheslak are fisheries biologists who are well known for their expertise in smolt migration issues in the San Joaquin River and the Delta. Scott Wilcox is a fisheries biologist with extensive experience in fish sampling and field studies. Dr. Peter Baker is a recognized expert in fisheries statistics and modeling of salmonid populations, especially, San Joaquin River chinook salmon populations.

g. Monitoring and Data Evaluation

The quality of the data will be framed within a Data Quality Objectives approach and will be monitored by a rigorous QA/QC program. The collected data will be made freely available to interested agencies. Senior technical review and input will be requested from potentially interested stakeholders, such as the Contaminants Branch of USFWS, IEP, and from the SWRCB. Quarterly progress reports will be prepared.

h. Local Support/Coordination with Other Programs/Compatibility with CALFED Objectives

The proposed project conforms to CALFED objectives of reducing losses to chinook salmon smolts due to water quality-related stressors. While several agencies collect baseline water quality, sediment quality data, and adult fish tissue residue data (USGS, IEP, CDFG), their focus is not oriented to collecting quantitative or cause-and-effect information regarding chemical conditions in the Delta during the period of smolt outmigration. Therefore, data collected from this project will supplement ongoing routine monitoring programs conducted by these agencies.

II. TITLE PAGE

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I-003758

III. PROJECT DESCRIPTION

1. Describe Features, Extent of Project, and Intended Approach

Introduction

Chinook salmon smolts are a priority species affected by many stressors . Several recent studies have noted that current smolt survival models inadequately incorporate water quality effects, especially given that chemicals in Delta waters may occur at concentrations capable of producing severe toxicity (Fox and Archibald 1997). Studies have noted metals (boron, selenium, molybdenum) (Paterson 1992, Finlayson 1978, Saiki 1995, 1992) and several pesticides (diazinon, simazine, metalochlor, cyanazine) (Saiki 1995, 1992, Sotero 1990, Gillian 1990) in San Joaquin River waters at concentrations capable of producing adverse effects on zooplankton and fish during the yearly rearing and outmigration period of January to July (USGS 1995).

The rapid uptake kinetics of waterborne pesticides and metals allow for the possibility that significant uptake into smolt tissues may occur on the order of hours to days, depending on factors such as lipid content, gill and respiratory activity and gill surface area. Therefore, both acute (short-term) and chronic (longer-term) exposures are possible. The effects of chemicals may be expressed directly as lethal effects (mortality) or as sub-lethal effects (e.g., impaired growth and metabolism) or indirectly as smolt starvation due to reduction of zooplanktonic food supplies. In addition, many organic chemicals exert a nonspecific toxic effect known as narcosis. Narcosis is a general depression in metabolic activity of the affected organism and is a well-studied phenomenon in aquatic biota (Abernathy et al. 1988, Mackay et al. 1992). Symptoms may include decline in swimming activity, or loss of balance and orientation (Michaelson 1997, Parkerton 1996). Thus, narcotic effects may severely reduce the fitness of smolts in their ability to migrate successfully through the Delta and then to adjust to the saline conditions of the estuary and open ocean. The effects of the non-chloride ionic constituents may be expressed as ionic and osmoregulatory stress and cell membrane disruption that affects healthy development and transition to the seawater environment. Ionic stress is also known to be induced by exposure periods of a few days (Saiki 1995, 1992) and salinity-adapted invertebrate communities have been reported to dominate in portions of the San Joaquin River (Leland and Fend 1997).

Smolts that are released near Mossdale in late April and early May as part of the yearly USFWS studies are typically 6–10 cm (average 8 cm) long and weigh 3.5–10 gm (average 6 gm). Their migration time through the Delta is estimated to range from 4 to 10 days, although some hatchery fish and most wild fish may take longer (up to 49 days). Their migration rate through the Delta is reported at 10–18 km/day (Kjelson et al. 1982). Their migration rates appear to accelerate with time. Wickwire and Stevens (1971), for example, estimated that smolts cover 8, 12, and 24 km/day in April, May and June, respectively. They are crepuscular feeders and consume primarily aquatic zooplankton such as cladocerans, copepods, crustaceans, amphipods and insects (Stevens et al. 1984). Typically, smolts remain in the upper 3 meters of the water column near the shoreline during daylight hours and become more evenly distributed in the water column during their feeding times and through the night (Sasaki 1966, Sagar 1987).

Study Design

The Lower San Joaquin basin and the Delta form an extremely complex system of waterways, flows, water quality and ecology, all of which may affect smolt survival. This study proposes a simplified approach that will focus first on understanding water quality in the basin during the time of smolt

migration in the first phase of the study. Succeeding phases of the project will focus on achieving better understanding of smolt condition, e.g., use of "live car" studies, bioassays, and/or additional sampling locations within the Delta.

During the period of late April to early May 1998, coded wire-tagged (CWT) smolts will be released at the Mossdale release point by USFWS, usually consisting of three releases over a 2-week period. The chemical assessment study will collect water, sediment and zooplankton samples from the upper 3 m of the water column at six locations beginning 2 days before the date of the first CWT release. The suggested sample locations include Mossdale, near French Camp Slough upstream of Stockton, Buckley Cove downstream of Stockton, Columbia Cut, near the mouth of the Mokelumne and Jersey Point (Figure 1). The intervening sample locations were selected because they are located in areas where smolt losses are thought to be heavy (USFWS 1992). The locations may be altered or modified as the literature review and the work plan are undertaken.

The study design for field sampling is summarized in Table 1. Sampling and analytical methods will follow USEPA-recommended protocols. Three water and zooplankton samples will be collected at each sampling location once every 48 hours, two nearshore samples (either side) and one mid-channel sample. The three samples will be composited into a single sample for water and one for zooplankton. Sediment samples will be collected twice a week at each location from two nearshore vicinities and one mid-channel sample. These will also be composited into a single sample from each location.

After release of the CWT fish from the hatchery, water, sediment and zooplankton samples will continue to be collected as described above. In addition, smolt samples will be collected daily at all of the six locations. The decision of whether or not to composite smolt samples will depend on the number and frequency of smolts captured. The sampling effort will continue for a total of 28 days, thus allowing a maximum of 11 days for the last released fish to reach Jersey Point. One boat with two project personnel will be employed for sampling. A back-up boat will be available, as well as additional personnel for packing and shipping of samples to the analytical laboratory. Sample locations will be documented by use of GPS instrumentation and UTM coordinates.

By the end of the 28-day sampling period, a total of 84 samples each of water and zooplankton and 48 sediment samples would be collected. The number of smolt samples may be variable, depending on migration rates and netting success. This proposal assumes that 72 smolt samples will be available for analysis (one sample per location every 48 hours over a 24-day period).

Water Samples

Water samples will be collected as grab samples from the upper 3 m of the water column from the boat and composited in the field in 0.33:0.33:0.33 ratio. The weighting towards nearshore samples is based on the fact that smolts are known to spend daytime hours resting in nearshore areas and therefore experience a greater exposure duration at these locations than the mid-channel. Samples will be collected in pre-cleaned bottles. In addition to laboratory analyses, field measurements of water quality will include dissolved oxygen, pH, turbidity, temperature and electrical conductivity (YSI field instrumentation or continuous recorders such as HydroLab/Datalogger). Mid-channel water velocity will also be measured. The samples will be marked with pre-labeled, adhesive labels and placed on ice. Water samples will be analyzed for wet chemistry parameters, chlorophyll a, for metals reported in the Delta, and pesticides known to be used in the areas surrounding San Joaquin River and Delta (Table 2).

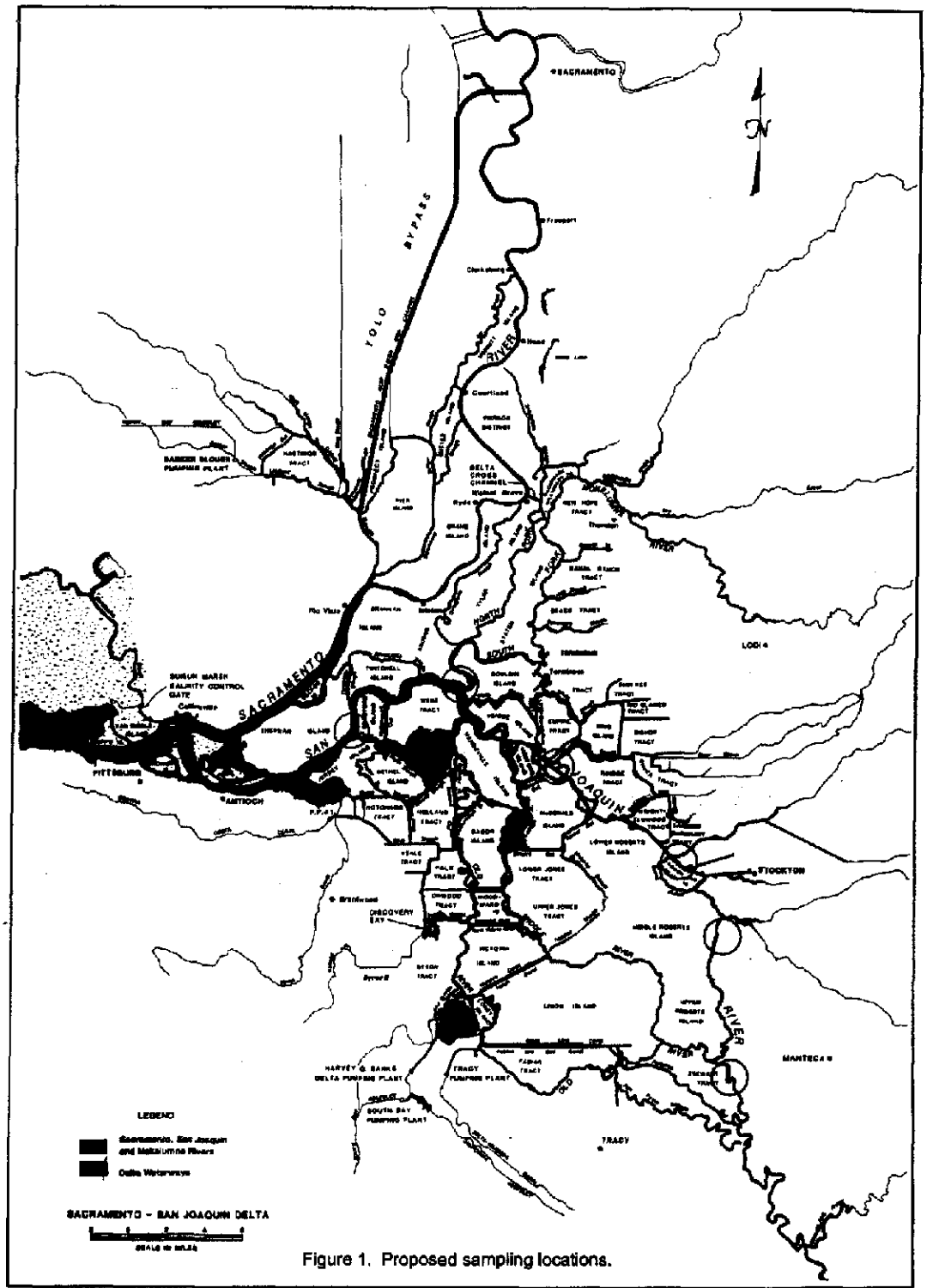

Figure 1. Proposed sampling locations.

Source: Sacramento Delta San Joaquin Atlas
California Department of Water Resources, 1993.

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TABLE 1 SUMMARY OF SAMPLING ACTIVITIES

Six Sample Locations: Mossdale, French Camp Slough, Buckley Cove, Columbia Cut, Mokelumne Mouth, Jersey Point				
Sample Matrix	Water	Sediment	Zooplankton	Smolts
Collection Method	Grab and composite	Grab and composite	Grab and composite	Electroshocking, pump screens, composite every 2 days
Collection locations	Nearshore and midchannel	Nearshore and midchannel	Nearshore and midchannel	Channel cross-section
Sampling Frequency	Every 48 hours over 28-day period	Twice a week over 28-day period	Every 48 hours over 28-day period	Daily over 24-day period
Sample size	84 (6 x 14)	48 (6 x 8)	84 (6 x 14)	72 (6 x 12)
Field Measurements	pH Dissolved oxygen Electrical conductivity Temperature Turbidity Flow velocity	-	Pre-sorting	Length Weight Morphology Condition

TABLE 2 SUMMARY OF POTENTIAL LABORATORY ANALYSES*

Sample Matrix	Water	Sediment	Zooplankton	Smolts
General / Wet Chemistry	pH Hardness Total Suspended solids (TSS) Total dissolved solids (TDS) Nitrogen Phosphorus Chlorophyll a	pH Ammonia Total organic carbon (TOC) Grain size distribution Dry weight	Families Genus (if appropriate) Density	Dry weight Lipid content
Ionic Stress	chloride sulfate sodium potassium calcium magnesium	-	-	Na^+-K^+-gill ATP-ase
Metal Stress	Antimony Arsenic Boron Cadmium Copper Lead Mercury Molybdenum Nickel Selenium Zinc	Antimony Arsenic Boron Cadmium Copper Lead Mercury Molybdenum Nickel Selenium Zinc	-	Antimony Arsenic Boron Cadmium Copper Lead Mercury Molybdenum Nickel Selenium Zinc
Pesticide Stress	Amides Chlorinated pesticides Carbamates Organophosphates Triazines	Amides Chlorinated pesticides Carbamates Organophosphates Triazines	-	Amides Chlorinated pesticides Carbamates Organophosphates Triazines

*Note: This is a preliminary list of analyses. The list of analytes may be modified based on data needs identified during work plan development.

Sediment Samples
Sediment samples will be collected from the boat by means of Ponar or Eckman dredges. They will be collocated with water sampling locations. The sampling devices will be drained of overlying water, the device opened and the upper 5cm of the sediment sample (the bioactive layer) transferred to pre-labeled plastic containers with tightly fitting lids. Compositing of sediment samples will be accomplished in the laboratory to minimize handling-related variance in redox-sensitive parameters. Sediment samples will be analyzed for grain size distribution, pH, ammonia, total organic carbon, metals, and pesticides (Table 2).

Zooplankton Samples
A plankton net will be employed to collect water column zooplankton samples (upper 3 m) that will be collocated with water and sediment samples. The samples will be pre-sorted in the field to the extent possible, then transferred to glass vials and preserved in formalin. Zooplankton samples will be examined by a qualified aquatic biologist. The most commonly present components will be identified by taxa to the most practicable taxa, family level, at a minimum, and if possible to the genus level. Estimates of relative abundance will be obtained by estimating density per unit volume of water.

Smolt Samples
Smolt samples will be collected by electrofishing and from pump intake points at locations collocated with the water, sediment, and zooplankton samples. Approximately 35 grams of fresh weight are required for the chemical analyses corresponding to a required sample size of 5–6 smolts per sample. The number of smolt samples will depend on the number of smolt that are collected at each sampling location and, therefore, it may not be possible to collect smolt samples that correspond to and are collocated with the three nearshore and mid-channel sampling points planned for the water, sediment and zooplankton sampling. However, this is acceptable since the smolts pass through the whole cross-section of river locations and are expected to integrate exposure to both nearshore and mid-channel habitats. Collected smolts will be measured in the field for length, weight (to the nearest milligram), and examined for obvious signs of stress and abnormal development (e.g., lesions, sores, tumors, deformities, finrot, mucus) and stored in pre-cleaned aluminum foil, then wrapped in clear plastic, labeled, and stored on ice. Smolt tissue will be homogenized as whole body tissue in the laboratory and analyzed for lipid content, gill ATP-ase content, metals, and pesticide residues (Table 2).

Literature Review
Since the chinook salmon smolts are undergoing smoltification during their progress through the Delta, their metabolism is passing through a rapid process of alteration and adjustment to accept chloride-based salinity (Folmar and Dickhoff 1980). Whether this process provides adaptability to divalent ions, such as sulfate, is unknown but appears doubtful (Saiki et al. 1995, 1992, Newman and Rice 1997). Literature regarding ionic stress will be critically reviewed regarding the effects of nonchloride ions on the smolt of anadromous fish.

The literature review will also focus on narcosis effects. Much of the chemical-specific toxicity literature reviewed to date has focused on toxic effects (mortality, reproduction) on adult salmonids or on development in fry, but not necessarily on smolts with their rapidly changing physiology. Available literature on narcotic effects will be searched because the potential for narcosis is dependent primarily upon whether a critical body residue has been reached and may occur at any life-stage. Therefore, the quantifying and predicting toxic of effects may be better accomplished by predicting the potential for narcosis in combination with other effects such as mortality and sublethal effects.

Data Handling

The collected data will be compiled and assembled in a relational database. The data will also be represented spatially as a GIS product using ARC/INFO and ARC/VIEW. Summary information and statistics regarding the following will be developed:

- water quality in the Delta during the period of smolt outmigration, by location and date
- sediment quality in the Delta during the period of smolt outmigration, by location and date
- type and abundance of zooplanktonic food available for smolt, by location and date
- tissue concentrations of metals, pesticides and ionic stress indicators in smolts

Toxicity Assessment

The following questions will be answered by means of statistical tests of significance, correlation analyses, trends analyses and ecological risk assessment procedures:

- What are the concentrations of toxic chemicals in water and sediment during the period of smolt outmigration?
- Are sediments likely to function as a continuous reservoir of toxic chemicals that may be released into the water column?
- Is there significant uptake and accumulation of toxic chemicals by smolts as they proceed downriver? is there a time and/or distance-related gradient of uptake?
- Are abundance and type of zooplanktonic distribution correlated with chemical, chlorophyll a and nutrient concentrations in water and sediment?
- Is there evidence of ionic stress in the smolts? i.e., is there a quantifiable relationship between ionic concentrations in water and gill ATPase activity?
- Are smolt condition and tissue concentrations correlated with chemical concentrations in water or food availability?

Adverse toxic effects to smolts may be expressed as mortality or as sublethal effects, such as impaired growth and metabolism. The potential for toxic effects will be evaluated as follows:

- Measured concentrations of chemicals in water and sediment will be compared against literature values of concentrations known to produce toxic effects in salmonids and zooplankton under acute exposures (e.g., LC_{50} values {concentrations lethal to 50 percent of the population}, LC_{10} values), and chronic exposures (chronic LOELs {Lowest observed effects levels}, NOELs {No observed effects levels}, etc.) The literature search will include databases such as AQUIRE (Aquatic Toxicity Information Retrieval), HSDB (Health Sciences Database) and Pollution Abstracts.
- Smolt tissue concentrations of chemicals will be compared against available literature on toxic body burdens, bioconcentration potential and effects levels for salmonid fishes.
- Both ambient and tissue concentrations will be examined to determine whether nonspecific but chemical-induced toxic effects such as narcosis can be expected to occur.
- Field observations of smolt condition will be compared against adverse effects that may be predicted on the basis of analytical data.
- Chemical-specific hazard quotients will be developed, i.e., the ratio of exposure concentration to a "safe" concentration where ratios exceeding one would indicate the potential for adverse effects
- Gill ATP-ase data will be reviewed in relation to literature findings to determine the potential for cause-and-effect relationships between smolt survival and ionic stress.
- Finally, an integrated evaluation of the potential effects of the three types of chemical stressors on smolt success will be developed.

Model Predictions
The information generated by this field study will be examined for incorporation into a population model for smolt survival that will include the following variables, as appropriate: toxic chemical concentrations in water, ion concentrations in water, toxic chemical concentrations in sediments, zooplankton density, predator presence, flow, and temperature. The relative contribution of the different variables in predicting the overall survival and outmigration success of the smolt will be determined in a preliminary model. With succeeding phases of the work (i.e., with two additional sampling events in the second and third year of the study), the model will be fine-tuned and calibrated. In addition, the existing adult chinook salmon population model (EACH) will be modified to track the contribution of several other variables, in addition to flow. Sensitivity analyses will be used to evaluate the relative importance, in a systems context, of toxicity to chinook salmon survival and production.

The utility of additional sampling locations and additional experimental and laboratory tests will be evaluated after the first year of field data collection.

2. Location/Geographic Boundaries
The geographic boundaries of the proposed project extend from Mossdale on the San Joaquin River downstream to Jersey Point, located in San Joaquin and Contra Costa counties.

3. Expected Benefits
This project focuses on Water Quality as a primary stressor and its effects on losses of the priority species, chinook salmon smolts. By focusing on smolts, this project applies to the fall-run chinook salmon race in the San Joaquin River.

The primary benefits of this project are:
- to provide a quantifiable and predictable understanding of water quality effects as they relate to chinook salmon smolt survival within the Delta
- to identify restoration and management actions that will have a much greater probability of success in reducing smolt losses by focusing on those factors that are likely to provide the most benefit.

Secondary benefits include:
- in the long term, to define and monitor conditions in the southern interior of the Delta in the portion of the water column that is used by smolts during the crucial period of outmigration
- to complement ongoing agency baseline monitoring programs by identifying new or additional appropriate sampling locations, parameters and times.

Third party benefits include:
- the data will be available to hatcheries for their planning and management use
- the data may be applicable to other priority species in the Delta that are exposed to chemical stress
- better design of agricultural and urban return water treatment facilities.

4. Background and Biological/Technical Justification
Large losses of hatchery released smolt are known to occur in the San Joaquin River and the Delta. This study will fill a number of data gaps that exist in monitoring and managing smolt outmigration success. A wide variety of chemical stressors are known to occur in the San Joaquin River and the Delta at

concentrations that may adversely affect the survival, growth and metabolism of salmon smolts and other biota, such as zooplankton, on which they depend for food (Baker et al. 1995, Newman and Rice 1997, Fox and Archibald 1997). Routine monitoring programs provide a general picture of water quality but are neither focused on the time or the locations that are relevant to smolt outmigration (USGS, IEP, SRWCB). By focusing on composite variables such as flow, current models are unable to distinguish between the magnitude of adverse effects caused by individual variables.

Smolt survival counts are also based on "end-of-Delta" locations and are, therefore, unable to assess migration success at different locations within the Delta (Stevens and Kjelson 1984, Paterson 1992). Thus, the identification and management of sections within the San Joaquin River or the Delta that may be particularly toxic to smolts cannot be accomplished at this time, but is a key restoration action that may provide vital benefits to this priority species. The lower San Joaquin River and the Delta form an extremely complex system of waterways, flows, water quality and ecology, all of which may affect smolt survival. This study proposes a simplified approach that will focus first on understanding water quality in the basin during the time of smolt migration in the first phase of the study. Succeeding phases of the project will focus on achieving better understanding of smolt condition and other areas of the San Joaquin Delta.

5. Proposed SOW

The proposed Scope of Work will include the following elements:

- Detailed work plan including a Sampling and Analysis Plan (SAP)and a Quality Assurance Project Plan (QApjP).
- Field sampling efforts and laboratory analyses of samples for the first year of the project.
- Quarterly progress reports
- Draft and Final reports of data, findings and recommendations from the first year's sampling events.
- Preliminary smolt loss model and technical documentation

6. Monitoring and Data Evaluations

The quality of the data will be framed within a Data Quality Objectives (DQO) approach and will be monitored by a rigorous Quality Assurance/Quality Control (QA/QC) program. The purpose of the DQO approach is to collect only that quantity and quality of data which is necessary to answer the questions that are being asked and the decisions that need to be made (USEPA 1996). The collected data will be made freely available to interested agencies. Senior technical review and input will be requested from potentially interested stakeholders such as the Contaminants Branch of USFWS and from the SWRCB. A technical advisory committee may be convened. Quarterly progress reports regarding work accomplished and budget spent will be submitted.

7. Implementability

The project is eminently implementable. All members of the project team are highly qualified personnel with relevant experience. All the equipment and facilities necessary are currently owned or available to the project team. The project effort will be coordinated with the CWT releases at Mossdale. It will also be coordinated with aspects of the Vernalis Adaptive Management Plan. Because it is designed to track variations in environmental conditions, the project is not affected by hydrologic or climatic conditions.

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IV. COSTS AND SCHEDULE

a. Budget

The budget for the project is presented in Tables 3a through 3c. The project staff are indicated along with their burdened rates. All relevant personnel are listed. As requested in the RFP, task costs are presented as a sum of labor, other direct costs (ODCs), and general and administrative costs on ODC. Analytical costs may increase or decrease slightly depending upon the actual number of samples analyzed and addition or deletion of analytes.

The total budget is $674,896. Garcia and Associates (GANDA) and its subcontractor, EA Engineering, Science, and Technology (EA) are committed to the objectives of the CALFED restoration goals and are making good faith contributions to the project in the form of cost reduction beyond what would normally be charged to clients. GANDA will reduce the fees normally charged for program management and administration by 3% resulting in a reduction in cost offered of $12,855. EA will not charge for "usage" on vehicles, fax, phones, computers, copies and boats and thus offers a reduction in cost of $65,380. Therefore, the request for funding to CALFED amounts to **$596,662**. These reductions will be noted on each monthly invoice submitted.

B. Schedule Milestones

The schedule of activities is presented in Figure 3. The project will begin with a kick-off meeting between the project manager, technical team leaders and the CDFG staff in January 1998. The literature review and work plan preparation will be completed in February. Pre-field activities and preparation for sampling will take place in March and early April.

The actual sampling task will extend over a 4-week period from late April through late May within the required holding times. Chemical and biological laboratory analyses will be performed over a 2-month period in May and June. The evaluation of data for toxic effects assessment and the population modeling effort will be undertaken from July through October. These tasks will be performed in consultation with other technical experts, as necessary. The final report will be prepared and submitted in November and December of 1998. This will allow for recommendations to be developed and preparations to be made for the next phase of the project

C. Third Party Impacts

Since this project is limited to field sampling during a limited period of time and subsequent data analysis, no impacts to third parties are anticipated.

TABLE 3A

Name	Labor Rate	Task 1 Work Plan/Lit Review Hours	Task 1 Work Plan/Lit Review Total $	Task 2 Sampling Hours	Task 2 Sampling Total $	Task 3 Lab Analyses Hours	Task 3 Lab Analyses Total $	Task 4 Assessment/Modeling Hours	Task 4 Assessment/Modeling Total $	Task 5 Reporting Hours	Task 5 Reporting Total $	All Tasks
Baker, P.	$81.81	24	$1,963.34	0	$0.00	0	$0.00	80	$6,544.47	24	$1,963.34	$10,471.15
Cheslak, E.	$114.09	8	$912.73	0	$0.00	0	$0.00	16	$1,825.45	16	$1,825.45	$4,563.63
Garcia, J.	$124.17	16	$1,986.76	8	$993.38	0	$0.00	16	$1,986.76	16	$1,986.76	$6,953.65
Hanson, D.	$120.74	16	$1,931.88	8	$965.94	0	$0.00	60	$7,244.56	40	$4,829.71	$14,972.10
Horrigan, M.	$45.47	72	$3,273.89	200	$9,094.14	40	$1,818.83	40	$1,818.83	8	$363.77	$16,369.45
Mathews, M.	$58.01	0	$0.00	160	$9,280.99	0	$0.00	8	$464.05	8	$464.05	$10,209.09
Aramayo, R.	$54.69	16	$875.12	160	$8,751.19	260	$14,220.68	8	$437.56	0	$0.00	$24,284.54
Lukas, J.	$88.69	8	$709.56	8	$709.56	16	$1,419.11	24	$2,128.67	16	$1,419.11	$6,386.00
Sheehan, E.	$65.40	0	$0.00	0	$0.00	0	$0.00	16	$1,046.36	24	$1,569.54	$2,615.90
Vedagiri, U.	$108.18	40	$4,327.11	40	$4,327.11	80	$8,654.21	160	$17,308.43	80	$8,654.21	$43,271.07
Wilcox, S.	$94.84	32	$3,035.01	100	$9,484.39	0	$0.00	60	$5,690.64	40	$3,793.76	$22,003.79
Labor Subtotals		232	$19,015.38	684	$43,606.69	396	$26,112.83	488	$46,495.76	272	$26,869.69	$162,100.35
ODCs												
Per diem	30	0	$0.00	56	$1,680.00	0	$0.00	0	$0.00	0	$0.00	$1,680.00
Travel (mileage)	0.31	300	$93.00	5,600	$1,736.00	0	$0.00	0	$0.00	500	$155.00	$1,984.00
Miscellaneous	200	0	$0.00	28	$5,600.00	0	$0.00	0	$0.00	1	$200.00	$5,800.00
Equip. Usage	200	0	$0.00	28	$5,600.00	0	$0.00	0	$0.00	1	$200.00	$5,800.00
Supplies		0	$0.00	0	$5,000.00	0	$0.00	0	$0.00	0	$500.00	$5,500.00
Lab Analyses		0	$0.00	0	$0.00	0	$397,200.00	0	$0.00	0	$0.00	$397,200.00
Subtotal			$93.00		$19,616.00		$397,200.00		$0.00		$1,055.00	$417,964.00
Fee (EA)	15%		$13.95		$2,942.40		$59,580.00		$0.00		$158.25	$62,694.60
Total ODC			$106.95		$22,558.40		$456,780.00		$0.00		$1,213.25	$480,658.60
Project Subtotal			$19,122.33		$66,165.09		$482,892.83		$46,495.76		$28,082.94	$642,758.95
Fee (GANDA) 5%												$32,137.95
Project TOTALS												$674,896.90
* EA cost share will include no charges for equipment usage, rentals and fees on lab analyses												($65,380)
* GANDA cost share includes reduction in fees from 5% to 3%												($12,855)

FINAL TOTAL* **$596,662**

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TABLE 3B

Name	Raw Labor (+)	Benefits 29.88% (=)	Direct Labor w/Benefits	Overhead 113% (+)	Fee 7% (=)	Overhead Plus Fee	Labor Rate
Baker, P.	$27.67	$8.27	$35.94	$40.52	$5.35	$45.87	$81.81
Cheslak, E.	$38.59	$11.53	$50.12	$56.51	$7.46	$63.97	$114.09
Garcia, J.	$42.00	$12.55	$54.55	$61.50	$8.12	$69.62	$124.17
Hanson, D.	$40.84	$12.20	$53.04	$59.80	$7.90	$67.70	$120.74
Horrigan, M.	$15.38	$4.60	$19.98	$22.52	$2.97	$25.50	$45.47
Mathews, M.	$19.62	$5.86	$25.48	$28.73	$3.79	$32.52	$58.01
Aramayo, R.	$18.50	$5.53	$24.03	$27.09	$3.58	$30.67	$54.69
Lukas, J.	$30.00	$8.96	$38.96	$43.93	$5.80	$49.73	$88.69
Sheehan, E.	$22.12	$6.61	$28.73	$32.39	$4.28	$36.67	$65.40
Vedagiri, U.	$36.59	$10.93	$47.52	$53.58	$7.08	$60.65	$108.18
Wilcox, S.	$32.08	$9.59	$41.67	$46.97	$6.20	$53.18	$94.84

I-003772

TABLE 3C - LABORATORY ANALYSES

Sample Matrix	Wet Chemistry			Metals			Pesticides			Totals
	Unit Cost	No.	Total Cost	Unit Cost	No.	Total Cost	Unit Cost	No.	Total Cost	
Water	$200	84	$16,800	$300	84	$25,200	$1,500	84	$126,000	$168,000
Sediment	$200	48	$9,600	$300	48	$14,400	$1,500	48	$72,000	$96,000
Tissue	$50	72	$3,600	$300	72	$21,600	$1,500	72	$108,000	$133,200
Totals			$30,000			$61,200			$306,000	$397,200

GRAND TOTAL $397,200

XLS.0519738.USHAT1.1

I-003773

Effect of Toxics on Chinook Salmon Smolt

Task	Description	1998 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Task 1 - Work Plan and Pre-Field Activities													
Subtask 1.1	Literature Review												
Subtask 1.2	Work Plan Preparation												
Subtask 1.3	Equipment and Supplies Acquisition												
Subtask 1.4	Obtain Permits and Access Rights												
Task 2 - Sampling													
Subtask 2.1	Sample collection												
Task 3 - Sample Analyses													
Subtask 3.1	Water, sediment, tissue analyses												
Subtask 3.2	Zooplankton Analyses												
Subtask 3.3	QA/QC												
Task 4 - Data Evaluation and Modeling													
Subtask 4.1	Toxics Assessemnt												
Subtask 4.2	Population Modeling												
Task 5 - Reporting													
Subtask 5.1	Quarterly reports												
Subtask 5.2	Annual report												
Subtask 5.3	Public Presentation												

Figure 3. Schedule of year one activities.

XLS.0619738.USHAT2.1

V. APPLICANT QUALIFICATIONS

a. Staff Organization and Participating Parties

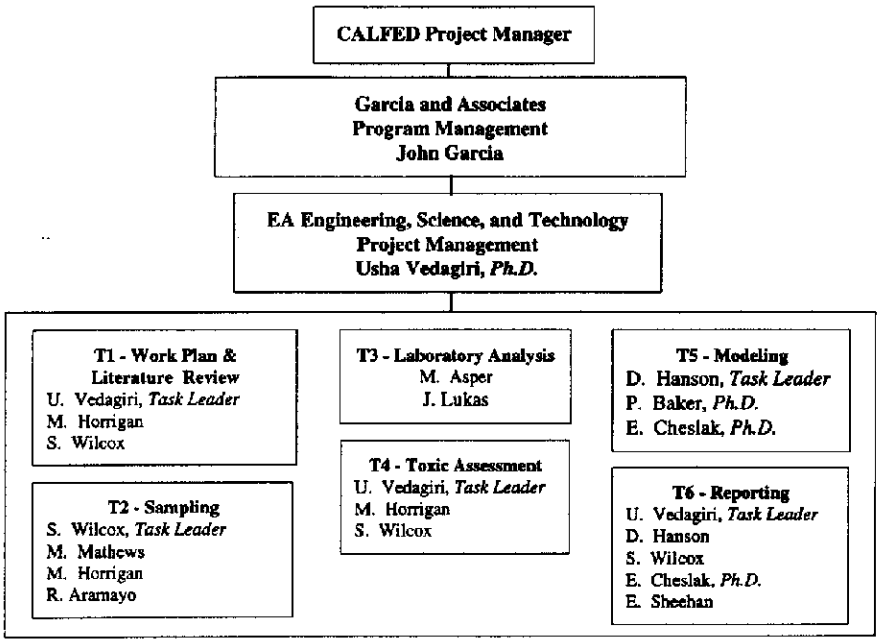

Figure 2. Project organization.

The prime contractor in this project is Garcia and Associates. Portions of the proposed work will be subcontracted to EA Engineering, Science and Technology (Exhibit A).

■ **John C. Garcia, Principal/Systems Ecologist** *Role: **Program Manager***
M.S., College of Forest Sciences, Univ. Washington, 1974 *24 years of experience*
Mr. Garcia is on the Board of Directors of the Pacific Environmental Resources Center and is the founder of GANDA. He has worked on riparian, instream flow and delta inflow issues under various regulatory requirements. He was principal investigator and project manager of the Mokelumne River Fisheries Management Plan, the Stream Corridor Inventory and Evaluation System, and many instream flow and temperature simulation studies. In addition, Mr. Garcia managed and conceived several fish population simulation models in the above systems. He has also been the PI for several entrainment studies and reservoir monitoring studies.

■ **Usha Vedagiri, Ph.D., Risk Assessment Manager/Ecotoxicologist** *Role:* **Project Manager**
PhD, Environmental Science, Rutgers University, New Jersey, 1989 *15 years of experience*
Dr. Vedagiri will also serve as the technical task leader for the **toxics assessment** portion of this effort. She is an aquatic toxicologist with research experience in the partitioning and bioavailability of toxic chemicals in aquatic and wetland ecosystems. She has conducted and managed numerous projects assess-ing the

exposure and effects of metals and organic chemicals on aquatic biota, including fish, zooplankton and vegetation in both freshwater and brackish environments. She is involved in the development and use of risk-based screening approaches and toxicity testing for the evaluation of petroleum-contaminated water and sediments in Pittsburgh, California and Barrow, Alaska and ecological risk assessment of oil and pesticide contaminated wetlands and waterways nationwide.

- **Scott Wilcox, Fisheries Biologist** *Role:* **Technical Task Leader/Field Sampling**

MEd, Natural Resource Management, Univ. California at Davis, 1989 *17 years of experience*

Mr. Wilcox will serve as the technical task leader for field sampling. Mr. Wilcox has extensive knowledge of the CALFED project and has experience in Central Valley fisheries, water quality issues. His expertise includes environmental impact analysis for fish, wildlife, and water quality; computer modeling of stream hydraulic and temperature conditions; and instream flow data collection and analysis. A representative project includes the CDFG and Reclamation District No. 2086 project in which Mr. Wilcox provided aquatic and terrestrial analyses for a shaded riverine aquatic and riparian habitat improvement project on Beaver Slough in the Sacramento/San Joaquin Delta for a levee habitat enhancement project.

- **Mary Asper** *Role:* **Task Leader/Laboratory Analysis**

Ms. Asper will serve as **the technical task leader for laboratory analyses**. She has over 11 years of experience with QA/QC procedures and SAP's relative to analysis of water, sediment and tissue samples.

- **David Hanson, Senior Fisheries Biologist** *Role:* **Technical Task Leader/Modeling**

MS, Fisheries and Wildlife Science, Utah State University, 1978

Mr. Hanson has extensive experience in fish habitat and population modeling. He has a highly quantitative background and extensive knowledge of Bay Delta fisheries issues and is a nationally recognized leader in the application of instream flow and other quantitative methodologies used to evaluate the relationships between streamflow and fish habitat.

- **Peter Baker, Ph.D., Senior Scientist, Fish Population Modeler** *Role:* **Modeler/Statistician**

PhD, Mathematics, University of California at Berkeley, 1987 *6 years of experience*

Dr. Baker is well known for his work in developing chinook salmon population models and is a member of the Bay-Delta Modeling Forum. He has been in charge of continued development and refinement of the EACH simulation model for San Joaquin chinook salmon populations. Supervised construction of a simulation model for chinook salmon spawning habitat use. Integrated water temperature estimates generated by a SNTEMP model with physical habitat estimates developed through PHABSIM. Developed a statistical model for estimating the effect of water temperature on survival of salmon smolts from mark-recapture data. Assisted in development of statistical models for estimating the sizes of chinook salmon runs from carcass count data.

- **Edward Cheslak, Senior Aquatic Ecologist** *Role:* **Senior Technical Review**

PhD, Aquatic/Systems Ecology, Utah State University, 1982 *25 years of experience*

Dr. Cheslak is a fisheries ecologist with experience in the population ecology of salmonid fishes. He has experience in conducting, directing, and evaluating applied ecological studies and experiments in aquatic ecosystems. He has analyzed the effects of nonpoint discharges, flow modifications, and habitat enhancement on water quality, fisheries and aquatic communities within streams. He is an internationally recognized expert in the application of the U.S. Fish and Wildlife Service Instream Flow Incremental Methodology.

■ **Michael Mathews, Watershed Specialist** *Role:* **Field Sampling Team Member**

BS, Resource Management, University of California at Berkeley, 1989

Mr. Mathews has extensive experience in field surveys and sampling of stream hydrology and aquatic biological surveys. While working for the Forest Service, Mr. Mathews coordinated closely with the USFWS and the Natural Resource Council partner agencies and developed restoration projects including gully stabilization, wet/dry meadow habitat enhancements, and culvert replacements.

■ **Mathew Horrigan, Risk Assessor** *Role:* **Field Sampling Team Member**

B.S., Environmental Toxicology, University of California at Davis, 1992

Mr. Horrigan is an environmental toxicologist with research experience in fish toxicology. He is a risk assessor whose primary focus is in human and ecological risk assessment, providing technical support and analysis for tasks such as gathering toxicity values, on-line literature search and review, technical report writing and review.

■ **Robert Aramayo, M.S., Aquatic Ecologist** *Role:* **Field Sampling/Zooplankton Taxonomy**

B.S., Forestory, Univ. California at Berkeley, 1987

Mr. Aramayo is an aquatic ecologist who has conducted research on aquatic insects, amphibians, reptiles, and fish throughout California. His experience includes investigations on aquatic systems ranging in size from small, intermittent tributaries to large rivers.

■ **Joseph A. Lukas, M.S., Fisheries Biologist** *Role:* **Zooplankton Assessment**

M.S., Fisheries Science, Virginia Tech, 1993

Mr. Lukas has worked on studies of fish communities analyses, instream flow studies, turbine mortality and entrainment modeling and Habitat Conservation Plans for anadromous fishes of the mid-Columbia River

C. Disclosure of COI, Provide References

Pursuant to California Government Code §1090, EA Engineering, Science, and Technology, Inc. is disclosing a remote interest in proposals submitted for funding under CALFED's 1997 Category III program. EA staff, as third tier subcontractors to the Bureau of Reclamation, have provided technical and administrative support to CALFED agency staff in the Restoration Coordination Program. In this capacity, EA staff have assisted with documentation of public meetings of the Ecosystem Roundtable, and compiled technical team meeting information for distribution to Roundtable members and the public. EA's legal counsel has determined that EA's participation as a subconsultant in contracts that may be awarded under the Category III program does not constitute a violation of California Government Code §1090.

Consistent with Government Code 4525, EA Engineering, Science, and Technology, Inc., was selected by Garcia and Associates to provide environmental services in the area of toxicology and laboratory analyses. The selection was made on the basis of qualifications and demonstrated competence for the requested services, including documentation of fair and reasonable prices. Project team members from Ganda and EA have worked together on several projects and have thus established strong working relationships and common resources.

References are as follows:

Mr. John Lempe	East Bay Municipal Utilities District	510-287-1127
Mr. Bernie Burham	Bureau of Indian Affairs	503-231-6750
Mr. Tim Ford	Turlock Irrigation District	209-883-8275
Mr. John Irwin	Southern California Edison Companies	818-302-8945

VI. COMPLIANCE WITH STANDARD TERMS AND CONDITIONS

a. Forms (attached)

b. Terms and Conditions Compliance

We have no objections to the standard terms and conditions presented in Attachment D of the CALFED-Bay Delta Program Request for Proposals 1997, Category III.

Exhibit A
Statement of Intent

This Exhibit is attached to and incorporated into this Agreement between Prime GARCIA AND ASSOCIATES, **and Consultant, EA Engineering, Science, and Technology, Inc. entered into** 26 JULY, 19 97.

Consultant expects, if Prime is awarded the Contract, to perform as a subconsultant to Prime. Prime's project manager is JOHN GARCIA **and will be the primary technical management point of contact for Prime.** _____ **will be the Prime's primary point of contact for all contractual matters.**

Consultant's Project Manager is USHA VEDAGIRI **and will be the primary technical management point of contact for Consultant.** FRITTS GOLDEN **will be the Consultant primary point of contact for all contractual matters.**

Prime and Consultant understands that the division of effort between Prime and Consultant will be highly dependant on the nature of the work assigned by Client, but at a minimum, will include the work in accordance with the proposal and as contracted.

Work assigned to Consultant will include the following:

1. Preparation of Work Plan, Sampling and Analysis Plan, Quality Assurance Project Plan.
2. Field Sampling Activities.
3. Laboratory Analyses - Chemical.
4. Toxics Assessment and Modeling.
5. Reporting.

I-003779

Item B

NONDISCRIMINATION COMPLIANCE STATEMENT

COMPANY NAME

The company named above (hereinafter referred to as "prospective contractor") hereby certifies, unless specifically exempted, compliance with Government Code Section 12990 (a-f) and California Code of Regulations, Title 2, Division 4, Chapter 5 in matters relating to reporting requirements and the development, implementation and maintenance of a Nondiscrimination Program. Prospective contractor agrees not to unlawfully discriminate, harass or allow harassment against any employee or applicant for employment because of sex, race, color, ancestry, religious creed, national origin, disability (including HIV and AIDS), medical condition (cancer), age, marital status, denial of family and medical care leave and denial of pregnancy disability leave.

CERTIFICATION

I, the official named below, hereby swear that I am duly authorized to legally bind the prospective contractor to the above described certification. I am fully aware that this certification, executed on the date and in the county below, is made under penalty of perjury under the laws of the State of California.

John C. Garcia
OFFICIAL'S NAME

7-27-99
DATE EXECUTED

EXECUTED IN THE COUNTY OF: Marin

PROSPECTIVE CONTRACTOR'S SIGNATURE

Principal
PROSPECTIVE CONTRACTOR'S TITLE

Garcia & Associates (GANDA)
PROSPECTIVE CONTRACTOR'S LEGAL BUSINESS NAME

I —0 0 3 7 8 0

Item 12

Agreement No. _____

Exhibit _____

STANDARD CLAUSES –
SMALL BUSINESS PREFERENCE AND CONTRACTOR IDENTIFICATION NUMBER

NOTICE TO ALL BIDDERS:

Section 14835, et. seq. of the California Government Code requires that a five percent preference be given to bidders who qualify as a small business. The rules and regulations of this law, including the definition of a small business for the delivery of service, are contained in Title 2, California Code of Regulations, Section 1896, et. seq. A copy of the regulations is available upon request. Questions regarding the preference approval process should be directed to the Office of Small and Minority Business at (916) 322-5060. To claim the small business preference, you must submit a copy of your certification approval letter with your bid.

Are you claiming preference as a small business?

✓ Yes* _____ No

*Attach a copy of your certification approval letter.